DSN Research and Technology Support

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The activities of the Development Support Group in operating and maintaining the Venus Station (DSS 13) and the Microwave Test Facility (MTF) are discussed and summarized and progress noted. Major activities include preparation for a planned "automated station demonstration" and equipment modification and testing required therefor, flux density measurements of the radiation from the Planet Jupiter and various radio sources, commencement of active collection of solar energy data at DSS 13, on-antenna testing and successful implementation of the 400-kW X-band planetary radar system into DSS 14, completion of the on-site system testing and shipment of the DSS 43 100-kW transmitter system, continued transmission of clock synchronization timing signals to the overseas 64-m antenna stations, expanded activity in support of the Pioneer 10 and 11 science program as Pioneer 11 passed by Jupiter, and continued support of various radio science activities planned in the FY 75 JPL Radio Science Plan.

During the two-month period ending December 15, 1974, the Development Support Group, in its operation of the Venus Station (DSS 13) and the Microwave Test Facility (MTF), made progress on various projects as discussed herein.

I. In Support of Section 331

Station Automation (Pulsars)

As part of the overall DSN Station Automation Project (RTOP 68 "Station Monitor and Control"), a demonstration is planned using the Venus Station to perform a pulsar track under remote control from JPL in Pasadena.

In addition to the modifications to the computer and 26-m antenna servo system previously discussed (Ref. 1), the waveguide switching system has also been interfaced with the SDS-930 computer. The SDS-930 computer now has *control* of the input termination for the maser, i.e., either the antenna feedhorn or the ambient temperature waveguide load can be selected as the input termination for the maser. The SDS-930 computer can *monitor* which termination is in use, and also monitor the polarization which has been selected by the operator. As a result of previous testing, the servo system has been further modified to connect the SDS-910B antenna pointing input error signals directly to the rate amplifier, rather than coming in through the integrator. The computer now performs the integration with software. This connection is *only* effective when the computer is being used as part of this demonstration.

Testing of the system being automated consumed 121 hours, while actual observation of pulsars, at 2388 MHz, left-circular polarization (LCP), with the 26-m antenna, was performed for 70-1/4 hours. The pulsars observed are tabulated in Table 1.

II. In Support of Section 333

A. Radio Star Calibration

With the receiver tuned to 2278.5 MHz, and the 26-m antenna adjusted to receive right-circular polarization (RCP), received flux density measurements were made of radio sources Cassiopeia A, Cygnus A, and Virgo A during 44-1/4 hours of observation. These measurements are made in a semi-automated fashion using the noise adding radiometer (NAR) with programmer to control antenna movement and data taking cycles through the medium of an interface with the SDS-910B antenna pointing computer.

B. Sky Survey

With the 26-m antenna fixed in azimuth and progressively positioned in elevation, 503 hours of data were automatically collected during the night and weekend hours when the station is not manned. Completing one cycle of elevation positions at 88.8 deg, a new cycle was started at 80.0 deg, and by the end of the period observations had been taken through 80.6 deg elevation. Additionally, 24 hours of observation of the pole star, Polaris, were performed. All observations are made at 2295 MHz, with the 26-m antenna adjusted to receive RCP and the NAR collecting and storing the data on magnetic tape.

C. Faraday Rotation

With the two systems under evaluation performing well, the residue of the earlier installation (two rotating antenna systems, receivers, and test oscillators) was collected and returned to the Stanford Research Institute. Some difficulty was experienced with the data recording system being triggered by noise, but a modification performed by Bruce Parham of Section 333 solved that problem, and, at the end of the period, the system is working well.

D. Solar Energy Instrumentation

In support of the project to gather precision data on solar energy impinging on the Goldstone area, the Solar Energy Instrumentation Data Acquisition System has been transferred from DSS 14 to DSS 13 along with the associated sensors. This system consists of a multiplexer, analog-to-digital converter, programmer, various readouts, clock, and digital magnetic tape recorder with a small printer providing a record for operator use. Additionally, for off-line use, there is a digital tape player and a line printer. As currently configured, the system has eight analog and four digital channels, with a capability of approximately 300 total analog and digital channels for which cards are available. Three sensors (outdoor air temperature, dew point hygrometer, and pyranometer) are currently collecting data. The system is installed in building G-60 with the pyranometer installed on the roof.

Additionally, two mirror test tables have been set up in the desert northeast of the Microwave Test Facility (MTF). One table will be periodically cleaned while the other will be left untouched; the mirrors on both tables will have reflectivity measurements made periodically.

III. In Support of Section 335

A. X-Band Planetary Radar

Radio frequency (RF) testing at the 300-kW RF power level was successfully accomplished with the feedcone on the DSS 14 antenna. Full transmit system testing, under closed-loop phase control, was then performed for a 5-hour period, during which careful radiation survey measurements were made. Later, radiation intensity survey measurements were also taken with the antenna in "worst case" Saturn tracking positions. In neither case were dangerous levels found at any ground position. The survey is described in more detail elsewhere in this issue.

During the first operational radar tracks starting December 10, 1974, the transmitting system performed well, although some trouble was experienced with the receiver and correlator. Later, a malfunctioning traveling-wave tube was removed and replaced in the buffer amplifier.

Although DSS 14 personnel have been provided with "red-lined" documentation suitable for operation and troubleshooting, work is continuing on preparation of documentation suitable for transfer, along with cleanup of the remaining items of Engineering Change Order (ECO) implementation required.

B. DSS 43/63 100-kW Transmitter Testing

The Philco Ford Corporation (PFC) installation team has left for Spain to aid in the installation of the DSS 63 100-kW transmitter system, and all equipment has been shipped to them.

For both systems, modifications have been made to the dual ignitron deck assemblies, and successful checkout accomplished. Also, spare filter reactors and all logic cards have been tested while the focusing magnet assemblies have been modified and tested.

Using the "test bed," four rebuilt and modified X-3060 klystrons have been tested. One failed the acceptance test and was returned to the manufacturer (Varian Associates). The other three required on-site retuning by a manufacturer's engineer prior to acceptance. Using one of the retuned klystrons, a 12-hour "stability" test at the 100-kW power level was performed on the RF cabinet destined for DSS 43. After successful completion of this test, the system was dismantled, the transformer rectifier assembly was weighed (14,526 kg (32,025 lb)), and shipment to Australia was accomplished. Only minor items remain to be shipped.

C. Microwave Power Transmission

In preparation for the forthcoming prototype panel testing (March 1975), the power distribution transformer in the collimation tower building was relocated, and ground fault interrupters were put into the circuits to protect all power outlets. In preparation for installation of the final array, all existing microwave dishes were removed from the tower to minimize wind loading.

D. Block IV Receiver/Exciter (DSS 14)

Support of work on the Block IV Receiver/Exciter Subsystem has continued. This work included the modification of the temporary receiver and exciter manual control panels, fabrication of temporary cabling, and general subsystem troubleshooting and maintenance.

Subsystem performance testing and test procedure verification have been started and will continue. In preparation for doppler frequency error tests, the long-run hardline coaxial cables used in the Block IV Receiver/Exciter at DSS 14 are being tested using conventional procedures, insertion loss, time domain reflectometry and spectrum analysis. Past experience has shown that these tests may locate only the more severe cabling faults. It is therefore planned to use the special Digital Instrumentation Subsystem (DIS) monitor program for final evaluation. If possible, a comparison with similar tests on the present Block III Receiver/Exciter cabling will be made.

Preliminary work has been started to provide the capability for rework and testing of Block IV Receiver/Exciter electronic modules at DSS 13 utilizing contractor personnel. This would facilitate the completion of the subsystem.

A total of 97 manhours of support has been provided at DSS 14 by Development Support Group JPL personnel during the last two months.

IV. In Support of Section 391

Differential VLBI

As part of the overall DSN effort to develop the capability to navigate a spacecraft using distant radio sources as references, we provided tracking support to fast-switching VLBI measurements between the Pioneer spacecraft and various reference radio sources. A total of 21 hours of station support, of which 13 hours were actual tracking, was provided.

V. In Support of Section 422

Clock Synchronization Transmissions

The punched paper tapes, which are used as input data by the station computers with which to accomplish clock synchronization transmissions, have shown gradually increasing error rates due to improper sprocket hole punching and spacing. During the last two months several reschedulings were required and some transmissions were canceled for this reason. When the December tapes arrived, the error rate was so high that complete replacement was necessary. The replacement tapes, which were punched on a different machine at JPL, are usable. During this period six transmissions for a total time of 6-3/4 hours have been made as scheduled by the DSN.

VI. In Support of Section 825

A. Pioneer 10, 11 Science Support

DSS 13 continued to provide an average of 14.5 hours per week of observation. Measurements of the radiation level from Jupiter and the radio source calibrators tabulated in Table 2 were made at 2295 MHz, with the 26-m antenna adjusted to receive RCP. Observations were made for a total of 130-3/4 hours, with the data being semi-automatically collected by the NAR.

B. Interstellar Molecular Recombination Line Search

Continuing with the attempt (Ref. 2) to detect recombination lines of carbon, 51 hours of support were given to this project. During the 36-3/4 hours of actual tracking, observations were made of the region around W51 and S140, using a frequency of 2273.9 MHz with the antenna adjusted to receive RCP.

Similar observations are also made on the DSS 14 64-m antenna and are part of the JPL Radio Science Plan for FY 75 described as "Interstellar Microwave Spectroscopy," OSS-188.

References

1. Jackson, E. B., and Price, A. L., "DSN Research and Technology Support," in *The Deep Space Network Progress Report 42-24*, p. 78, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1974.
2. Jackson, E. B., "DSN Research and Technology Support," in *The Deep Space Network Progress Report 42-22*, p. 111, Jet Propulsion Laboratory, Pasadena, Calif., Aug. 15, 1974.

Table 1. Pulsars selected for test observation at DSS 13 (10/16–12/15)

0031−07	1237+25	1929+10
0329+54	1604−00	1933+16
0355+54	1642−03	2021+51
0525+21	1706−16	2045−16
0823+26	1749−28	2111+46
0833−45	1818−04	2218+47
1133+16	1911−04	

Table 2. Radio source calibrators used for Pioneer science support (10/16–12/15)

3C17	3C147	3C353
3C48	3C309.1	PKS 0237-23
3C123	3C348	